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OF OUTER SPACE

CENTRES FOR SPACE SCIENCE AND TECHNOLOGY EDUCATION - A PROGRESS REPORT

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INTRODUCTION

1. The present report focuses on the steps taken to date, the results thereof and the planned follow-up actions on the United Nations initiative to establish a Centre for Space Science and Technology Education in each of the four regional commissions in the developing countries. While practically every aspect of space science and technology can be grouped under four broad categories - basic space science, satellite communications, satellite meteorology and remote sensing - the initial emphasis of the Centres will be on in-depth education, research and applications programmes in satellite meteorology and remote sensing as these relate directly to environmental monitoring and natural resources management.

I. MANDATE

2. The General Assembly, at its forty-fifth session, in its resolution 45/72 of 11 December 1990, endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space (COPUOS) that:

> "... the United Nations should lead, with the active support of its specialized agencies and other international organizations, an international effort to establish regional centres for space science and technology education in existing national/regional educational institutions in the developing countries." (A/AC.105/456, annex II, para. 4 (n))

II. RATIONALE AND PROPOSALS FOR THE CENTRES

3. The rationale for the establishment of these Centres as well as the summary of the project proposals, contained in documents SAP/90/001-004, entitled "Centres for Space Science and Technology Education",* are presented in the annex to the present report. The summary includes the objectives, output, input, programme, curriculum (annex, table I), equipment (annex, table II), and functioning of the Centres (annex figure 1).

III. STEPS TAKEN TO DATE

4. Following the approval by COPUOS, at its 1990 session, of the recommendation of its Scientific and Technical Subcommittee on the establishment of the Centres for Space Science and Technology Education, the Outer Space Affairs Division developed and published a set of project

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* Documents SAP/90/001-004 are available in the Outer Space Affairs Division, United Nations Headquarters, New York.

documents (SAP/90/001-004, see para. 3 above) which are to serve as the guide for the establishment of the aforementioned Centres in developing countries. The documents were made available to all Member States, the regional commissions concerned (Economic Commission for Africa (ECA), Economic Commission for Latin America and the Caribbean (ECLAC), Economic and Social Commission for Asia and the Pacific (ESCAP) and Economic and Social Commission for Western Asia (ESCWA)) as well as governmental and non-governmental institutions.

Communications and consultations

5. The United Nations Secretariat has also initiated the following communications and consultations in respect of the Centres.

6. On 14 September 1990, the recommendation of COPUOS to the General Assembly on the Centres was communicated to the four regional commissions in the developing countries. Their assistance was sought in identifying potential host countries for the Centre in their respective jurisdiction. They were also requested to collaborate with the Outer Space Affairs Division in organizing the evaluation missions to potential host countries and their institutions. All four regional commissions in the developing countries have declared their interest in participating in the evaluation missions; one of them will do so if United Nations Headquarters or any other source can provide the funding for its representative.

7. On 8 February 1991, the following were sent:

(a) Notes verbales Nos. SAP/91/L.20/ECA, ECLAC, ESCAP and ESCWA (see annex I to the present report) were sent to all Member States in the developing countries requesting them (1) to support both financially and materially the establishment and operation of the Centre in their region, and (2) to indicate their interest in hosting the Centres;

(b) In response to these notes verbales, the following countries have offered to host the Centre in their respective region:

(i) ECA: Kenya, Nigeria and Zimbabwe;

(ii) ECLAC: Argentina, Brazil, Chile and Mexico;

(iii) ESCAP: Bangladesh, China, India, Indonesia, Iran (Islamic Republic of), Malaysia, Pakistan, Sri Lanka and Thailand;

(iv) ESCWA: Iraq, Jordan, Oman, Syrian Arab Republic and United Arab Emirates;

(c) Note verbale No. SAP/91/L.21/Centre (see annex II to the present report) was sent to 37 developed countries of Asia, Australasia, Europe and North America requesting them (1) to participate in the evaluation missions to potential host countries/institutions and (2) to support financially, materially and through institutional linkages the establishment and operation of these Centres.

8. On 1 April 1991, a letter (Ref. No. SAP/91/L.40) was addressed to the Administrator of the United Nations Development Programme (UNDP), requesting the participation and support (financially and material) of UNDP in (a) the evaluation mission and (b) in the establishment and subsequent operation of the Centres, particularly through funding allocations in the 5th UNDP cycle programmes and the UNDP/United Nations Environment Programme (UNEP)/World Bank Global Environment Facility (GEF) Programme.

9. In May/June and September/October 1991, consultation missions were undertaken with the representatives of the Governments of the following nine countries in their respective capitals: Australia, Canada, Finland, Germany, the Netherlands, Norway, Spain, Sweden and the United States of America. These consultation sessions, which took place in the capital of each of these countries, addressed the background and justifications for the Centres, including their programmes, funding arrangements, support from potential host countries, institutional linkages and management structure. The United Nations also used the consultation sessions to appeal to these countries for their financial, material and institutional support for the Centres as described under "Contributions of and responsibilities by the parties to the project" in part II, G of the project documents (SAP/90/001-004). The United Nations has addressed a follow-up letter of appeal to each of these countries. At the present moment, the United Nations is awaiting the response of each of these countries. Additional consultation missions are planned to other countries in 1992.

10. From 4 to 11 November 1991, consultations were held with the Assistant Administrator of the UNDP Regional Bureau for Latin America and the Caribbean and with the representatives of the Assistant Administrators of the UNDP regional bureaux for Africa, Asia and the Pacific and Western Asia. These consultations were follow-up actions to the letter of 1 April 1991 addressed to the UNDP Administrator. At present, each of these bureaux is evaluating the requested support for the Centre in its region of operation, taking into consideration the financial resources that are available for the UNDP fifth cycle regional programmes and the interests of Member States.

11. On 11 and 27 November 1991, the Secretariat requested the 19 countries that have offered to host the four planned Centres to complete a two-page questionnaire titled "Centre for Space Science and Technology Education: host country commitment questionnaire" in order to ascertain the level of commitment of each Government to the Centre it has offered to host. The questionnaire addressed, in part, the "Contributions of, and Responsibilities by the Parties to the (Centre) Project" (part II, G of project documents SAP/90/001-004). The questionnaire focused on four main areas of contribution: (i) personnel, (ii) space requirements (for classrooms, computer room, conference hall, work room, office space for professional and administrative personnel and consultants, library, storage space and living accommodations), (iii) equipment (photographic laboratory, access to international and national communication network, meteorological data receiving and processing facilities, and additional relevant equipment), and (iv) financial resources to support the Centre's actual budget (see annex IV of documents SAP/90/001-004 for budgets estimated in 1990).

IV. CONTRIBUTIONS IN SUPPORT OF THE CENTRES

A. Potential host countries

12. A number of Member States have responded positively to the questionnaire referred to in paragraph 11 above. These include:

(i) Africa

(a) Nigeria. On 7 February 1992, the United Nations received from the Government of the Federal Republic of Nigeria an official confirmation of its decision to offer contributions in the four requested categories - personnel, space, equipment and finance. The Government also offered Obafemi Awolowo University, Ile-Ife, and the University of Nigeria, Nsukka, as host institutions.

(ii) Asia and the Pacific

(a) Islamic Republic of Iran. On 3 December 1991, the United Nations received from the Government of the Islamic Republic of Iran an official confirmation of its decision to offer contributions in the four requested categories - personnel, space, equipment and finance. The Government also offered its Telecommunication University within its Ministry of Posts, Telegraph and Telephone as the host institution;

(b) Indonesia. On 4 December 1991 and on 16 January 1992, the United Nations received from the Government of Indonesia official confirmations of its decision to offer contributions in the four requested categories - personnel, space, equipment and finance. The Government also offered its Institut Teknologi Bandung (ITB) as the host institution;

(c) Sri Lanka. On 9 December 1991, the United Nations received from the Government of Sri Lanka an official confirmation of its decision to offer contributions in two of the four requested categories - personnel and space. The Government also informed the United Nations that the host institution would be the University of Moratuwa, Moratuwa, in collaboration with the Arthur Clarke Centre;

(d) Thailand. On 26 December 1991, the United Nations received from the Government of Thailand an official confirmation of its decision to offer contributions in the four requested categories - personnel, space, equipment and finance. The Government also offered the King Mongkut Institute of Technology Ladkrabang as the host institution;

(e) China. On 30 December 1991, the United Nations received from the Government of China an official confirmation of its decision to offer contributions in the four requested categories - personnel, space, equipment and finance;

(f) India. On 22 January 1992, the United Nations received from the Government of India an official confirmation of its decision to offer contributions in three of the four requested categories - personnel, space and equipment. The Government informed the United Nations that its offer of financial contributions would be made shortly. The Government also offered the Indian Institute of Remote Sensing (IIRS), Dehra Dun, as the host institution.

(g) Malaysia. On 3 February 1992, the United Nations received from the Government of Malaysia an official confirmation of its decision to offer contributions in two of the four requested categories - space and equipment. The Government also informed the United Nations that its proposed host institution will be the University of Malaya.

(iii) Latin America and the Caribbean

(a) Chile. On 27 November 1991, the United Nations received from the Government of Chile an official confirmation of its decision to offer contributions in the four requested categories - personnel, space, equipment and finance. The Government also offered the University of Chile and the Catholic University as host institutions;

(b) Mexico. On 23 January 1992, the United Nations received from the Government of Mexico an official confirmation of its decision to offer contributions in the four requested categories - personnel, space, equipment and finance. The Government also offered to host the Centre through the National Autonomous University of Mexico, the Mexican Institute for Communications and the National Institute for Geography, Statistics and Informatics.

(iv) Western Asia

(a) United Arab Emirates. On 22 January 1992, the United Nations received from the Government of the United Arab Emirates an official confirmation of its decision to offer contributions in three of the four requested categories - personnel, space and equipment. The Government also informed the United Nations that its offer of financial contributions would be made shortly. The Government further offered the United Arab Emirates University as the host institution.

B. Donors

13. A number of potential donors have responded positively to the notes verbales referred to in paragraph 7 (c) above and to the consultations and the follow-up correspondence referred to in paragraph 9 above. These include:

Spain. On 11 December 1991, the United Nations received from the Government of Spain an official confirmation of its interest, in principle, (a) to sponsor the Centre for Space Science and Technology Education in Latin

America and the Caribbean, and (b) to participate in the evaluation mission to the potential host countries/institutions of that Centre.

V. NEXT STEPS

A. Evaluation missions and selection of host countries and institutions

14. Prior to the selection of a host country/institution(s) for a Centre in any of the regions, an evaluation mission to the potential host countries/institutions in the region will be undertaken. The organization of such a mission presupposes that there is adequate funding commitment for the said Centre.

15. The purpose of the evaluation mission (one mission to each regional commission) is to provide an accurate and informative report that could assist in the selection of the host country/institution(s) for each regional Centre. The report of the mission should contain sufficient indications of whether the Governments and host institutions visited will provide the support necessary for the Centre's successful establishment and sustained operation.

16. Those participating in the mission in each region would include some or all of the following: (i) a renowned physical science educator from the region, (ii) a distinguished remote sensing/environmental science educator from outside the region, (iii) a representative from each of the following: (a) each of the potential donor countries, (b) the regional commission, (c) the United Nations Outer Space Affairs Division, (d) the specialized agencies of the United Nations and (e) the UNDP in the country being visited.

B. Agreements between the host countries and the United Nations

17. Following the selection of the Centres' host countries and institutions, the necessary legal instruments will be developed and entered into by the host countries and their institutions, on the one hand, and the United Nations (the Outer Space Affairs Division and the concerned regional commissions) on the other. This initial agreement shall relate only to the establishment and the first four years of operation of each Centre. Thereafter, all decisions on the management and functioning of each Centre will be determined by the Governing Council, on the one hand, and the host country/institution(s) on the other. (See para. 30 of the annex to the present report for further details on the Governing Council.)

C. Developmental activities

18. Upon the signature of the aforementioned initial agreements, a group of experts will be appointed and will be charged with the tasks described in paragraph 29 (b) of the annex to the present report.

D. Inauguration of programme

19. A successful completion of the activities enumerated in paragraph 29 (b) of the annex to this report would be followed by the inauguration of each Centre and the admission of the first set of educators and research and application scientists into the programme of each Centre.

VI. A FIELD TEST AND COMMENTS ON THE CENTRE CONCEPT

A. Field test

20. In collaboration with the Government of Sweden and its institutions (the Swedish Agency for International Technical and Economic Cooperation (BITS), the Swedish Space Corporation Satellitbild and the University of Stockholm), the United Nations began a field test of the concept of the Centres in 1990. This experiment began with the organization of a five-week training course on remote sensing education for educators held in Sweden in May/June 1990. The course was organized in order (i) to test the reality of the concept of the Centres for Space Science and Technology Education and (ii) to determine whether, through their academic and professional activities, the participants could indeed serve as the focal point for indigenous capability development in their respective institutions and countries. The course was attended by 26 African educators.

21. The Government of Sweden and its institutions that co-organized and hosted the 1990 course were very satisfied with its outcome and have invited the United Nations to co-sponsor a similar course in 1992 for the benefit of educators from the international community (developing countries). The United Nations has accepted this invitation.

22. The reports from the representatives of the Government of Sweden, the participants and the United Nations representatives at the 1990 course affirmed that much had been accomplished within the five-week period of the course. Certainly, a more in-depth programme through the Centres for Space Science and Technology Education should achieve much more.

B. Comments

23. Comments on the merits of and the need for the Centres for Space Science and Technology Education and their programmes have been received from 32 entities (including Member States, the United Nations system and the international scientific community). On the whole, the views are very supportive of the Centre concept; some also offered constructive suggestions on programme content and duration, curriculum, increase in the equipment for the Centres, admission of research and application scientists to the Centres' programme, policy and management of the Centres, etc. Most of the proposals have been adopted.

24. A complete text of all the comments received on the concept of the Centres, together with the views of the participants in the above-mentioned 1990 United Nations/Sweden course, are available, on request, from the Outer Space Affairs Division of the United Nations, room S-3260A, telephone (212) 963-7255; fax (212) 963-4879 or (212) 963-7998.

VII. EXISTING REGIONAL TRAINING CENTRES AND THE PLANNED CENTRES FOR SPACE SCIENCE AND TECHNOLOGY EDUCATION

A. The existing regional centres

25. The existing regional remote sensing training centres in Africa (Nairobi; Ile-Ife, Nigeria; Ouagadougou) and Asia (Bangkok) were established to provide Member States with the following: (i) services in surveying, mapping and remote sensing, (ii) training for nationals of Member States in surveying, mapping and remote sensing and (iii) data and results of studies, research and tests carried out by the centres. A number of the centres are undertaking application projects for their Member States and providing short-term training for junior-level technicians from user agencies of the countries they serve. Most of them are not equipped, in terms of both manpower and equipment, to conduct any study, research or tests but none of them is providing any long-term education programme. In 1989, the Centre at Ile-Ife began an application-oriented postgraduate diploma programme in remote sensing. In 1988, the Outer Space Affairs Division of the United Nations coordinated the UNDP-sponsored curriculum development exercise for this programme.

B. The planned Centres

26. The United Nations initiative to establish a Centre in each region will focus on education in space science and technology. Because of the prevailing global circumstances, the initial activities of these Centres will address the development of skill and knowledge in, and the use of space science and technology (Earth Observation satellites including satellite meteorology) in the management of global natural resources and in the monitoring of the global environment. Future activities of the Centres are expected to include basic space sciences and satellite communications. The objectives and output of the planned Centres for Space Science and Technology Education are described in paragraphs 25-27 of the annex to the present report. The participants in the Centres' programme will be university educators and research and application scientists.

27. On the completion of their programme at the Centres, these individuals should become multiplying factors in their chosen profession in their own countries. Individually and collectively, they should become major nuclei around which teams with innovative capability could be formed. The Centres and their graduates should be able to strengthen the capabilities of institutions of higher learning and national and regional remote sensing user assistance and training centres and thereby enhance the capabilities of the

countries and regions they serve, in order to contribute effectively to national, regional and international environmental monitoring and natural resources management programmes.

Annex 1

Note verbale to developing countries on the Centres

Reference: SAP/91/L.20/ESCAP[1]

The Secretariat of the United Nations presents its compliments to the Permanent Representative of ... to the United Nations and has the honour to refer to its resolution 45/72, adopted on 11 December 1990, at its forty-fifth session, in which the General Assembly endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space and directed as follows (document A/AC.105/456, Annex II, para. 4 (n)):

> "Taking into account paragraph 9 (c) of General Assembly resolution 44/46, the United Nations should lead, with the active support of its specialized agencies and other international organizations, an international effort to establish regional centres for space science and technology education in existing national/regional educational institutions in the developing countries."

It should be noted that the United Nations Secretariat has brought the above recommendation of the Committee on the Peaceful Uses of Outer Spaced and the endorsement of the General Assembly on the establishment of the Centre to the attention of the Executive Secretary of the Economic and Social Commission for Asia and the Pacific (ESCAP) and has requested him to ascertain the interest of ESCAP Member States in hosting this Centre. In this connection, a copy of the working project document No. SAP/90/002 titled "Centre for Space Science and Technology Education (Asia and the Pacific)", which has been prepared by the Outer Space Affairs Division of the Department of Political and Security Council Affairs for the establishment of the Centre in Asia and the Pacific, is attached.[2]

In its resolution 37/90 of 10 December 1982, the General Assembly endorsed the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE-82), and mandated the United Nations Space Applications Programme, among other things, to assist Member States in the development of their indigenous capability in space science and technology. As indicated in para. 5 of the note of the Secretary-General of the United Nations, Ref. SAP/90/L.66 of 17 December 1990, the International Space Year also offers the

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[1] The text of the notes verbales SAP/91/L.20/ECA, ECLAC and ESCWA are identical to this one except for regional identification.

[2] Annex enclosed. Documents SAP/90/001-004 are available in the Outer Space Affairs Division, United Nations Headquarters, New York.

UNITED NATIONS NATIONS UNIES

United Nations and the international community a unique opportunity to achieve major progress in the implementation of the recommendations of UNISPACE-82.

Today, the rational exploitation of the Earth's natural resources, the management of its environment and the programmes needed to achieve these goals are receiving global attention. The building of necessary indigenous capability, at the local level, to support the participation of the developing countries in such programmes is a major necessity. The establishment of the Centre for Space Science and Technology in Asia and the Pacific is a culmination of the efforts of the Space Applications Programme in this direction. The objectives of the Centre are contained in paras. 11 and 12 of the document; the justifications for its establishment are contained in paras. 13 through 16. Para. 17 describes a number of steps that led to the evolution of the project document.

The Outer Space Affairs Division, the Economic and Social Commission for Asia and the Pacific, and other entities of the United Nations system, particularly UNDP, FAO, UNESCO and WMO will participate in the establishment of this Centre. At the present time, arrangements are being made to undertake an evaluation mission to potential host countries/institutions for this Centre. The evaluation mission will assess the viability of the potential host institution(s), i.e. infrastructure, institutional/governmental support, existing educational programmes and all other support that would be provided by each potential host country for the Centre.

A number of ESCAP Member States have already indicated their interest to host this Centre; the United Nations is presently awaiting further indications of interest of ESCAP Member States to host this Centre from the Executive Secretary of ESCAP. The evaluation mission to potential host countries in Asia and the Pacific in respect of this Centre is expected to take place early in the second-half of this year.

The support of Member States for the establishment of the Centre in the ESCAP region is not only essential but of paramount importance. The United Nations invites the participation of the Government, both financially and materially, in the establishment of these Centres. In order that the establishment of this Centre could proceed as scheduled in the attached project document, it would be greatly appreciated if the response of the Government to this note could be sent to the Executive Secretary of ESCAP in Bangkok, by 15 May 1991 with a copy of the response forwarded to the Under-Secretary-General, Department of Political and Security Council Affairs, United Nations Headquarters, New York, N.Y. 10017.

8 February 1991 S.B.

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Annex II

Note verbale to industrialized countries on the Centres

Reference: SAP/91/L.21/Centre

The Secretariat of the United Nations presents its compliments to the Permanent Mission of ... to the United Nations and has the honour to refer to its resolution 45/72, adopted on 11 December 1990, at its forty-fifth session, in which the General Assembly endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space and directed as follows (document A/AC.105/456, Annex II, para. 4 (n)):

> "Taking into account paragraph 9 (c) of General Assembly resolution 44/46, the United Nations should lead with the active support of its specialized agencies and other international organizations, an international effort to establish regional centres for space science and technology education in exising national/regional educational institutions in the developing countries."

It should be noted that the United Nations Secretariat has brought the above recommendation of the Committee on the Peaceful Uses of Outer Space and the endorsement of the General Assembly on the establishment of these Centres to the attention of the Executive Secretaries of the Economic Commissions and has requested them to ascertain the interest of Member States in their respective region, in hosting these Centres. In this connection, a copy each of the working project documents Nos. SAP/90/001 - 004 titled "Centres for Space Science and Technology Education", which have been prepared by the Outer Space Affairs Division of the Department of Political and Security Council Affairs for the establishment of these Centres in the four economic regions, are attached.[1]

In its resolution 37/90 of 10 December 1982, the General Assembly endorsed the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE-82), and mandated the United Nations Space Applications Programme, among other things, to assist Member States in the development of their indigenous capability in space science and technology. As indicated in para. 5 of the note of the Secretary-General of the United Nations, Ref. SAP/90/L.66 of 17 December 1990, the International Space Year also offers the United Nations and the international community a unique opportunity to achieve major progress in the implementation of the recommendations of UNISPACE-82.

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[1] Annexes enclosed. Documents SAP/90/001-004 are available in the Outer Space Affairs Division, United Nations Headquarters, New York.

UNITED NATIONS NATIONS UNIES

Today, the rational exploitation of the Earth's natural resources, the management of its environment and the programmes needed to achieve these goals are receiving global attention. The building of necessary indigenous capability, at the local level, to support the participation of the developing countries in such programmes is a major necessity. The establishment of the regional Centres for Space Science and Technology is a culmination of the efforts of the Space Applications Programme in this direction. Part II of each of the project documents contains each Centre's objectives (Sections A and B) and the justifications for their establishment (Section C). Section D of Part II describes a number of steps that led to the evolution of these project documents.

The Outer Space Affairs Division, the Regional Economic Commissions and other entities of the United Nations system, particularly UNDP, FAO, UNESCO and WMO will participate in the establishment of these Centres. At the present time, arrangements are being made to undertake evaluation missions to potential host countries/institutions for these Centres. The evaluation missions will assess the viability of the potential host institutions, i.e. infrastructure, institutional/governmental support, existing educational programmes and all other support that would be provided by each potential host country for these Centres.

A number of Member States have already indicated their interest to host the Centre in their respective regions. The United Nations is presently awaiting further indications of interest of other Member States to host the Centre in their region from the Executive Secretary of each of the Economic Commissions. The evaluation mission to each of the regions is expected to take place early in the second half of this year.

The support of Member States for the establishment of these Centres is not only essential but of paramount importance. The United Nations invites the participation of the Government, both financially and materially, in the establishment of these Centres. In order that the establishment of these Centres could proceed as scheduled in the attached project documents, it would be greatly appreciated if the response of the Government to this note could be received by the Under-Secretary-General, Department of Political and Security Council Affairs, United Nations Headquarters, New York, N.Y. 10017, by 15 May 1991.

8 February 1991

S.B.

Annex III

RATIONALE FOR THE ESTABLISHMENT OF THE CENTRES AND SUMMARY OF THE PROJECT PROPOSALS

INTRODUCTION

1. The ever changing state of the planet Earth, brought about in part by man-made interventions, is creating global concerns. Today, these concerns include global desertification, deforestation, soil erosion, acid rain, air pollution, as well as others; they are individually and collectively creating a global change whose magnitude and direction are largely unknown.

2. Many countermeasures aimed at correcting these environmental problems have been proposed and in some cases agreed to at intergovernmental levels. For example, the General Assembly, in its resolution 1721 C (XVI) of 20 December 1961, called for a study on "measures to advance the state of atmospheric science and technology so as to provide greater knowledge of basic physical forces affecting climate and the possibility of large-scale weather modification". Similarly, the Montreal Protocol of 1989 called for international efforts and measures for controlling and subsequently eliminating ozone-destroying pollutants. A number of countries and intergovernmental and non-governmental organizations are studying these problems in order to be able to formulate appropriate policies. For example, the World Meteorological Organization (WMO) and the International Council of Scientific Unions (ICSU) responded to the aforementioned General Assembly resolution and mounted the Global Atmospheric Research Programme (GARP) to observe the global atmosphere on an intensive scale and to have an unprecedented description of it through one annual cycle. The achievements of GARP are well known, including (i) the development of new and advanced methods of data acquisition and analysis, (ii) marked improvements in weather forecasting and (iii) accelerated progress in climate research by stimulating the development of global models.

3. Today, the maintenance of global forests is an essential part of any climate protection programme. At its first of three meetings in a tropical forest country (Brazil) in June 1988, the International Tropical Timber Organization added its voice to the global demand for tropical rain forest conservation and reforestation. In June 1992, Brazil will also host the United Nations Conference on Environment and Development, with a view to forging the emergence of cooperative, collective and global environmental conservation and management strategies.

I. ENVIRONMENTAL INFORMATION: EXPLORING THE EARTH FROM SPACE

4. In the last two decades, the world has witnessed the evolution of the observation of the Earth from space, a process that has introduced new dimensions into the collection of Earth resources and environmental data. Of

equal importance is the rapid analysis and effective utilization of these data in a coherent manner in order to establish the trend of ongoing global changes.

5. Experiences gained from regional and global research efforts are now being transferred to a number of major global environmental and resource development programmes; Earth observation satellites will serve as significant and essential tools in these endeavours.

6. Specifically, the international community is now embarking on a number of long-term programmes such as the International Geosphere-Biosphere Programme (IGBP) and Mission to Planet Earth (MPE). The objective of IGBP is to describe and understand the interactive physical, chemical and biological processes that regulate the total Earth system, including the changes that are occurring in the system, and the manner in which they are influenced by human activities. In order to facilitate regional collaboration and research efforts on these global change issues, ICSU, the sponsor of IGBP, plans to establish a network of regional research centres around the world. Through MPE, a programme initiated by most of the space-faring nations, internationally coordinated space-based platforms will chart pollution, deforestation, the greenhouse effect, depletion of the ozone layer and other threats to the Earth's environment. The Joint Communiqué of the Economic Summit held in Paris, in July 1989, added its voice to the global concern on the interrelationship between the state of the Earth's atmosphere and the well-being of mankind on Earth by concluding that decisive action was urgently needed to understand and protect the Earth's ecological balance, and urging all countries to give further impetus to scientific research on environmental issues, to develop necessary technologies and to make clear evaluations of the economic costs and benefits of environmental policies.

7. Because of the ever-expanding frontier of knowledge in science and technology, including Earth observation from space, the acquisition, transmission, processing, analysis and subsequent utilization of environmental information in social and economic development programmes will be intensified with the passage of time. The latest effort in this regard is the microwave sensor system which, because of its all-weather capability, can penetrate rain and clouds, thus enhancing the possibilities of obtaining needed information from otherwise cloud-covered uncharted areas such as the tropics.

8. Today many countries, both developed and developing, are applying high-resolution satellite data to upgrade their Earth resources information systems, and in some cases to obtain for the first time information on different aspects of their environment. Such information can serve as a basis for decision-making as well as for monitoring the outcome of past decisions. The availability of such data can assist these countries to better understand and safeguard their immediate environment, as well as provide opportunities for a more efficient management and productive harnessing of their natural resources.

9. Where appropriate and relevant, major international funding agencies and institutions responsible for bilateral aid have requested the use of such

environmental data in the execution of projects they fund. During the past few years, the United Nations and its specialized agencies (such as the United Nations Environment Programme (UNEP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the World Bank) and the Commission of the European Communities (CEC) have employed remote sensing data, especially the data acquired by the Landsat Thematic Mapper (TM), SPOT and MOS satellites for use in programmes and projects in developing countries. In this connection, and through a number of Executing Agencies, UNDP is carrying out more than 200 projects that are related to the applications of remote sensing data. Projects to be executed within the Global Environment Facility, a joint programme of the World Bank, UNEP and UNDP, will also make use of remote sensing data.

II. EXISTING LEVEL OF KNOWLEDGE IN THE DEVELOPING COUNTRIES

10. Although all countries are contributing to global environmental problems, all countries do not have the requisite capability needed for their solution. The contributions of the developing countries to MPE and IGBP will also be limited.

11. Among the many factors that create bottlenecks in project implementation in the developing countries, only those that are related to the development of indigenous capability are addressed in the present report. These factors include: (i) the shortage of qualified human resources at the local level and (ii) the resulting dependence of most ongoing projects, at the local level, on foreign expertise. Once the latter is withdrawn, such projects often falter; one of the major reasons for such failures is that the country counterpart is generally not versed in the fundamentals of the principles/concepts being applied. Furthermore, country-counterparts often acquire their knowledge through short term training courses, which are mostly applications-oriented and are usually conducted abroad. Through short-duration courses or on-the-job training, such individuals are often taught skills that can be used to execute specific tasks. In most instances, it is impossible to adapt such skills to other tasks without a fundamental knowledge and an understanding of the principles and methodology involved. Only in-depth education can provide such knowledge and skills.

III. NEEDED: IN-DEPTH LONG-TERM EDUCATION

12. Most of the activities being executed in the developing countries either through bilateral aid or by international funding agencies are also carried out as part of a "technology transfer" process. However, technology transfer can lead to knowledge development if it is pursued, not only with a preoccupation with what a particular technology can do, but also it provides an environment through which local scientists and technologists can gain a good understanding and knowledge of how and why the technology that is being applied works the way it does.

13. There is an emerging consensus within the international community that if technology transfer is to succeed, efforts must be devoted to knowledge development at the local level. Such an approach should provide the participating individuals with the necessary educational opportunities, taking into full consideration the local economic, cultural and infrastructural conditions.

14. At the professional level, an individual should be exposed to the acquisition, transmission, processing, analysis and applications of environmental and natural resources data through an intensive educational process. This approach provides an appropriate environment for the assimilation of the fundamental principles involved, which is critical to a successful development of knowledge in the discipline.

15. The World Bank has also examined the development of indigenous capability through education and training, particularly in Africa. In its 1989 report titled "Sub-Saharan Africa: from crisis to sustainable growth", the World Bank opined that if Africa is to benefit from advances in environmental information systems and related sciences and technologies, it must improve its science and technology education and training and aim at the highest standards for at least a minimum core of specialists. Foreign aid should go towards building excellence and relevance in African science and technology and helping to link institutions to others outside Africa.

16. At its Third Meeting, held at Heidelberg, Germany, from 10 to 12 April 1991, the Advisory Committee of the World Bank's Programme on Environment Information Systems in Sub-Saharan Africa noted that "indeed, most cooperation programmes are geared to short training sessions to fill short-term objectives ...". On education and training, the Committee also noted that:

"(i) If a country is to have an effective environment information system, it must have policy makers and administrators capable of appreciating the applications and implications of the information, and scientists, engineers, technicians and teachers capable of developing, adapting, applying and teaching the technology. Both education and training are required to build up these skills;

"(ii) Education provides the individual with an understanding of the subject, and training teaches him to carry out specific tasks, when knowledge of the subject as a whole may not be essential. To create the awareness, flexibility and motivation necessary to adjust to rapidly changing conditions, education is likely to be more effective than training for tasks which, because of the nature of new technologies, alter very quickly." a/

17. The Committee concluded its meeting with the following recommendations:

"(i) A professional approach to environment information as the basis for the viable sustainability of environment information systems should be encouraged. Staff capacity must be developed in the short,

medium and long terms. In the short term, needs can be met by training courses and self-training. In the longer term, basic education and university courses must cover environmental concerns and related subjects, including the information aspects, more thoroughly;

"(ii) African university courses relating to environment information should be developed, and they should be tied in with national environment information programmes. Students should have the opportunity to get practical experience in operational systems. The Committee endorses the strengthening of all viable university resources, and university networking is commended;

"(iii) Cooperation based on long-term partnerships should be established between more developed institutions and African ones (both public and private institutions), to ensure the continuity of technology transfer. Such cooperation programmes should include long-term educational and staff-training schemes. The Committee recommends that a review be prepared on who in Africa is offering training, which organizations are twinned, and which universities in Africa and overseas might be interested in twinning arrangements." b/

18. In a recently released report (para. 2.2.2) of Directorate General VIII of the Commission of the European Communities, the latter noted that "conventional approaches to technology transfer, such as training courses and short-term, in-country demonstration projects are useful educational tools, but on their own, they will not result in effective and permanent integration of remotely sensed techniques into operational programmes." c/

19. In identifying the several steps needed to arrive at practical applications of remote sensing for environmental monitoring and natural resources management, the CEC report opined that:

(i) Research and development are needed to integrate remote sensing techniques into resource management systems;

(ii) Research and development of remote sensing data processing, analysis and interpretation provide the scientific basis for application of the techniques. d/

20. The 1987 Brundtland report on the "World Commission on Environment and Development", which was presented to the General Assembly of the United Nations, recommended that "environmental education should be included in and should run throughout the other disciplines of the formal education curriculum at all levels - to foster a sense of responsibility for the state of the environment and to teach students how to monitor, protect and improve it. Global awareness could be fostered by encouraging contacts among teachers from different countries, for instance, in specialized centres set up for this purpose." e/

IV. CENTRES FOR SPACE SCIENCE AND TECHNOLOGY EDUCATION

21. The developing countries would need a highly educated core of (i) specialists who could teach the courses proposed in the World Bank and Brundtland reports and (ii) research and application scientists who could initiate and carry out the research and application programmes enumerated in the CEC report.

22. Between 1983 and 1986, the United Nations Programme on Space Applications (hereafter referred to as "the Programme") also undertook an evaluation of the needs and requests in different aspects of space science and technology which were submitted by Member States. The analyses reveal that there is a major need in the developing countries for intensive indigenous capability development which can only be attained through long-term educational programmes. High on the list of priorities was the need for in-depth education in the fundamentals of the various fields of space science and technology, as well as the need for opportunities to gain experience in a research environment.

23. Beginning in 1985, the United Nations, through the Programme, embarked on a path towards the development of indigenous capability in space science and technology at the local level. The development of the Centres' project documents (SAP/90/001-004) is the culmination of these efforts. The initiative for the establishment of the Centres for Space Science and Technology Education is in agreement with the above proposal of the Brundtland report; it also aims at providing the education programme and research opportunities deemed essential by the World Bank and the CEC reports. The Programme has long concluded that addressing the present imbalance between the human impact on the environment and measures to safeguard it for future generations would require an in-depth and long-term education programme on environmental information systems with emphasis on remote sensing and related technologies through the education of relevant university educators and research and application scientists.

24. In support of the above initiative of the Programme, the General Assembly, at its forty-fifth session, in its resolution 45/72 of 11 December 1990, endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space (COPUOS) that:

> "... the United Nations should lead, with the active support of its specialized agencies and other international organizations, an international effort to establish regional centres for space science and technology education in existing national/regional educational institutions in the developing countries." (A/AC.105/456, annex II, para. 4 (n))

A. Objectives

25. On the whole, each of the Centres for Space Science and Technology Education will (i) contribute to sustainable development of natural resources (air/water/land) and (ii) provide a crucial supplementary input for biodiversity conservation and other related environmental programmes through the development of in-depth knowledge and skills of educators and research and application scientists in environmental information systems with emphasis on remote sensing, satellite meteorology and relevant technologies at the local level.

26. Specifically, each of the Centres will be established at an existing and viable institution of higher learning or a research centre in each region. The programme of each Centre will:

(a) Develop skills and knowledge of university educators, environmental research scientists and project personnel, initially in remote sensing and related technologies for subsequent application in national development and environmental management programmes;

(b) Assist those educators to develop environmental and atmospheric sciences curricula that they can use to advance the knowledge of their students in their respective institutions/countries;

(c) Develop the skills of the environmental research scientists and project personnel in the design, development and application of remote sensing techniques in natural resources management and biodiversity protection;

(d) Assist the educators and research and application scientists who have completed the programme at the Centres to undertake pilot projects, and to use the knowledge and skills they have acquired at the Centres in their teaching and research activities in their respective countries;

(e) Support those educators, scientists and project personnel who have completed this programme, with expertise from the Centres and other appropriate international institutions, and to invite them regularly to workshops and seminars organized by the Centres so that they can refresh their knowledge;

(f) Enhance regional cooperation in space science and technology programmes related to environmental monitoring and natural resources management, and support and contribute to the work of institutions of higher learning in each region and the activities of national/regional remote sensing user assistance and training centres.

B. Output of the Centres

27. The Centres would achieve the following:

(a) Contribute significantly to indigenous capability development in environmental information systems such as remote sensing, including satellite meteorology and related environmental disciplines in each participating country and region;

(b) Enhance scientific and technical education in each participating country and region;

(c) Enhance the quality and quantity of contributions of graduates towards the overall development of their respective nations and towards the management of the resources and the environment of their countries;

(d) Strengthen the capabilities of institutions of higher learning and national and regional remote sensing user assistance and training centres;

(e) Assist user agencies in Member States to strengthen their capabilities in the use of remote sensing for the management of their natural resources and environment;

(f) Enhance the capabilities of the countries and regions they serve to contribute effectively to national, regional and international environmental monitoring and natural resources management programmes.

C. Curriculum

28. The curriculum of each of the Centres will address in-depth understanding and subsequent integration of space science and technology into environmental monitoring and natural resources management programmes. A survey of the status of education programmes and materials in each region will be used to determine the level and scope of programmes to be included in the curriculum of each Centre. Through this process, participating educators should be part of the solution to the problems that confront their respective societies and should be equipped to provide their students and their own communities with the requisite knowledge in those disciplines. A general outline of a proposed curriculum is shown in table I below; this outline will be modified on the basis of the recommendations of a panel of educators who are being invited to assess the education programmes in each region.

D. Programme of the Centres

29. In order to achieve the objectives outlined above, the establishment of each Centre is designed to be implemented in four phases.

(a) Phase 1 (preparatory activities) includes a number of parallel preparatory activities, such as:

(i) Identification of and negotiation with the host Government/institutions;

(ii) Raising of necessary funds and securing technical support to establish the Centres;

(iii) Evaluation of facilities and resources being provided by host Government/institutions.

(b) Phase 2 (development activities): consists of the hiring of a group of experts whose responsibilities will include the following:

(i) Assessment of the education levels in each region (e.g., existing university courses and research programmes, audiovisual materials, etc.);

(ii) Development of each Centre's curriculum on the basis of the assessment in (i) above;

(iii) Identification and acquisition as well as development of scientific and technical education materials appropriate for each region;

(iv) Identification, acquisition and installation of necessary equipment and laboratory facilities (see table II below) and the hiring and training of support personnel in the use and maintenance of the equipment and facilities;

(v) Identification and recommendation of professional personnel, including visiting scholars within the region and from the international community, to be recruited for the Centres;

(c) Phase 3 (operational phase) will focus on the operational aspect of the Centre and will include the following:

(i) Hiring of each of the Centre's staff;

(ii) Organizing and implementing the education programme for natural, physical and environmental science educators and scientists;

(iii) Organizing workshops for secondary and primary school teachers;

(iv) Providing research, education and application support services for national and regional institutions;

(v) Organizing a "continuing education" programme at each Centre for educators and research and application scientists, including graduates of the Centres;

(vi) Extending invitations to Member States to nominate able candidates from their academic and research institutions to participate in the various programmes of each of the Centres.

(d) Phase 4 (practical realization). Graduates of the Centres will:

(i) Return to their respective countries to implement their own pilot projects;

(ii) With the aid of the materials developed at each Centre, introduce the knowledge acquired into the education curricula and research and application activities in their own and in other institutions in their country;

(iii) Each Centre will organize evaluation workshops that will assess each participant's pilot project and provide feedback on the efficacy of each Centre's education and research programmes.

E. Management

30. Each of the Centres is to be managed by a governing council consisting of the following: (i) a representative of the host country, (ii) two representatives of the participating countries of the region, (iii) a representative of each of the donor countries, (iv) a representative of the Centre and (v) the representative(s) of the executing agency (in each case, this shall include a representative of the Outer Space Affairs Division of the United Nations, of the concerned regional commission and of the appropriate United Nations agencies). Figure I below shows the functioning of each Centre.

Notes

a/ "Present status of the Programme", Environmental Division for Africa, Technical Department, World Bank, August 1991, pp. 7 and 8.

b/ Ibid., pp. 2 and 3.

c/ "Remote Sensing of the Sahelian Environment", Commission of the European Communities, Technical Centre for Agriculture and Rural Cooperation, Lomé Convention, 1990, pp. 12 and 13.

d/ Ibid., pp. 69 and 70.

e/ See A/42/427, annex.

Table I

OUTLINE OF PROPOSED CURRICULUM

(a) Development of analytical skills (physics, mathematics, computer science, photogrammetry and cartography)

(b) Basic radiometry

(c) Fundamentals of meteorology

(d) Physics of imaging, including the principles of data acquisition, transmission and reception

(e) Principles of photo-interpretation (analogue and digital)

(f) Skills and knowledge development in remote sensing technology, including geographical information systems (GIS)

(g) Development of skills in applying remote sensing technology and GIS to specific application projects

(h) Development of research programmes

(i) Development and design of education and demonstration materials

(j) Curriculum development

(k) Development of skills and knowledge in computer-aided education

(l) Establishment and management of information systems

(m) Execution of research and application projects

(n) Weekly seminars on special topics on space technology

Table II

LIST OF EQUIPMENT FOR EACH CENTRE

(i)	Twenty microcomputer systems; six of these should have the potential for handling geographic information systems and relevant computer software for image analysis
(ii)	2 multi-channel radiometers for ground truth determination
(iii)	Photographic cameras (2) 35 mm
(iv)	35 mm slide-projectors (3)
(v)	Overhead projectors (3)
(vi)	Video cassette recorders (2); colour T.V. set (2)
(vii)	Office supplies
(viii)	Projection screens (2)
(ix)	Photographic supplies
(x)	Drafting supplies and lettering equipment
(xi)	Voltage regulators
(xii)	Dark room equipment
(xiii)	Audio cassette tape recorders (2)
(xiv)	A photo-copying machine
(xv)	Office furnishings
(xvi)	A small scale meteorological satellite receiving station
(xvii)	Satellite remote sensing images and air photographs
(xviii)	Three vehicles (2 field vehicles (Jeeps) and a car)
(xix)	Laboratory stereoscopes (17)
(xx)	Portable independent communication equipment for voice and data transmission/reception
(xxi)	Replacement parts, and other consumables, for the equipment listed above.

FIGURE 1. THE FUNCTIONING OF THE CENTRE